

## SIMPLE TYPES IN XML SCHEMA COMPLEX TYPES

### 5 BACKGROUND OF INVENTION

This invention relates to allowing the presence of a simple type in an XML Schema complex type.

10 Extensible mark-up language (XML) is a mark-up language for documents containing structured information. XML provides a facility to define tags and the structural relationship between them in the document. An XML Schema describes and constrains the content of XML documents.

15 The W3C XML Schema does not permit a complex type to include a simple type without defining a new element. Also if a complex type inherits from a Simple Type then it can have only simple content, i.e. it cannot have child elements. As a result, it is not possible to model accurately the XML Schema for the following XML stream where the contents of element *Fred* contains an *arbitrary string* (xxxx) , an *element Joe*, an *integer* (67890102), an  
20 *element Jim* and finally an *integer* (12345).

```
<Fred>xxxx<Joe/>67890102<Jim/>12345</Fred>
```

25 Such types of XML Streams are very common. The XML Schema specification does allow a *mixed* flag to be set in respect of a complex type so that an instance of the complex type can contain arbitrary strings between the elements. Nevertheless, you cannot precisely specify any order or position for the strings within the XML document, as illustrated in the example above.

30 This invention seeks to avoid some of the described drawbacks.

## SUMMARY OF INVENTION

5 The present invention describes an XML Schema and a parser for the aforescribed kinds of XML streams. More specifically, the subject invention seeks to, within the scope of existing XML Schema specifications, provide an approach to embed simple types within a complex type so an XML stream can have instances of the embedded simple types, even without the presence of XML elements. Because the approach is within the scope of existing XML Schema specifications, the approach is transparent to known XML parsers.

10 According to the present invention, there is provided an XML schema, comprising:  
at least one complex type, said complex type having a mixed flag set to true and including an element set to be a dummy element, said dummy element having a simple type, one of (i) a name of said dummy element and (ii) a name of said simple type being one of a  
15 predetermined set of names for use with a parser which, on parsing said schema, will interpret said dummy element as one of an embedded simple type and an inherited simple type.

20 According to another aspect of the present invention, there is provided a method of parsing, comprising: receiving an XML stream; parsing said XML stream on encountering a parent element in said XML stream, utilising an XML schema to locate a type for said parent element; where said type is a complex type, determining whether a mixed flag for said complex type in said schema is set to true; where said mixed flag is set to true, interpreting  
25 fragments embedded in said parent element in accordance with said complex type, each fragment being one of an arbitrary string and an element; where, in accordance with said complex type, an embedded fragment corresponds to a dummy element having a simple type, with one of (i) a name of said dummy element and (ii) a name of said simple type being one of a predetermined set of names, interpreting said embedded fragment as one of an embedded simple type and an inherited simple type. A computer readable medium containing computer  
30 executable instructions to affect the method is also provided.

According to a further aspect of the present invention, there is provided a parser, comprising:  
means for receiving an XML stream; means for parsing said XML stream means for, on  
encountering a parent element in said XML stream, utilising an XML schema to locate a type  
for said parent element; means for, where said type is a complex type, determining whether a  
mixed flag for said complex type in said schema is set to true; means for, where said mixed  
flag is set to true, interpreting fragments embedded in said parent element in accordance with  
said complex type, each fragment being one of an arbitrary string and an element; means for,  
where, in accordance with said complex type, an embedded fragment corresponds to a  
dummy element having a simple type, with one of (i) a name of said dummy element and (ii)  
a name of said simple type being one of a predetermined set of names, interpreting said  
embedded fragment as an embedded simple type.

Other features and advantages of the invention will become apparent from the following  
description in conjunction with the drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

The figure, which illustrates an example embodiment of the invention, is a schematic view of  
a system configured in accordance with this invention.

## DETAILED DESCRIPTION

The following approach is used so that, within the scope of existing XML Schema  
specifications, a mechanism/pattern is provided to embed simple types within a complex type  
in order that an XML stream can have instances of the embedded simple types, even without  
the presence of XML elements.

1. Custom simple types are used which extend the XML Schema simple types so a parser  
operating in accordance with this invention can recognize these special types. Each of these  
simple types has a name such that the set of these custom simple types provides a set of pre-  
determined names.

2. The mixed flag is set to true on the embedding complex type. -- As per XML Schema specifications, the *mixed* flag on the complex type indicates that its instance can have arbitrary strings in between the elements.

5

3. Elements or arbitrary strings of these custom simple types are created within the embedding complex type. These elements/arbitrary strings are wrapped under an anonymous group sequence in which *minOccurs* and *maxOccurs* on the sequence is set to 0. As per the XML Schema specification, if both of these flags are set to 0 then the XML instance of the complex type cannot have any occurrence of contents of sequence. In other words, such elements are dummy elements and logically they are not part of the complex type. In consequence, an XML parser which is not configured to operate in accordance with this invention will simply ignore this group. It is noted that the *minOccurs* and *maxOccurs* on the elements of these custom simple types have their usual meaning, i.e., they determine whether these elements are optional or mandatory.

10

15

By combining these constructs , a special case is created for the custom XML parser (i.e., a parser operating in accordance with this invention) to treat these dummy elements as just the simple types and to parse the arbitrary strings in the instance (a by-product of the *mixed* declaration defined on the embedding complex type) according to the defined type of the element.

20

Since the declaration of these dummy elements, wrapped under an anonymous group within the complex type, may be *positional* (by use of the “sequence” construct), the custom XML parser can ensure that such arbitrary strings in the XML instance adhere to the relative position of the declaration of these dummy elements in the complex type.

25

The XML instance generated for the complex type (containing these dummy elements) will parse successfully by any open source XML Schema complaint parser because it will contain arbitrary strings at the position where the dummy elements are defined; this is OK because the *mixed* flag on the complex type is set to true.

30

The following schema contains Customized Simple types to enable embedding of a simple type within a complex type and extending from a simple type.

- 5
- Types starting with name ComIbmMrmBaseValuexxxx are to be used in the scenario where a complex type extends a simple type.
  - Types starting with name ComIbmMrmAnonxxx are to be used in the scenario where a complex type includes a simple type.

10 The reference to “wmqi21” in the example is simply a reference to the customized parser (i.e., the parser operating in accordance with this invention).

```
<?xml version="1.0" encoding="UTF-8"?>
```

```
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
```

15

```

    <xsd:annotation>
      <xsd:documentation>
        ComIbmMrm_BaseValuexxx type to be used when a complex
type extends a simple type
      </xsd:documentation>
    </xsd:annotation>
  
```

20

```

    <xsd:simpleType name="ComIbmMrm_BaseValueString">
      <xsd:restriction base="xsd:string"></xsd:restriction>
    </xsd:simpleType>
  
```

25

```

    <xsd:simpleType name="ComIbmMrm_BaseValueInt">
  
```

```
        <xsd:restriction base="xsd:int"></xsd:restriction>
    </xsd:simpleType>
```

```
<xsd:simpleType name="ComIbmMrm_BaseValueDateTime">
```

```
5        <xsd:restriction base="xsd:dateTime"></xsd:restriction>
    </xsd:simpleType>
```

```
<xsd:simpleType name="ComIbmMrm_BaseValueDate">
```

```
        <xsd:restriction base="xsd:date"></xsd:restriction>
```

```
10    </xsd:simpleType>
```

```
<xsd:simpleType name="ComIbmMrm_BaseValueTime">
```

```
        <xsd:restriction base="xsd:time"></xsd:restriction>
```

```
</xsd:simpleType>
```

15

```
<xsd:simpleType name="ComIbmMrm_BaseValueFloat">
```

```
        <xsd:restriction base="xsd:float"></xsd:restriction>
```

```
</xsd:simpleType>
```

20

```
<xsd:simpleType name="ComIbmMrm_BaseValueDecimal">
```

```
        <xsd:restriction base="xsd:decimal"></xsd:restriction>
```

```
</xsd:simpleType>
```

```
<xsd:simpleType name="ComIbmMrm_BaseValueBoolean">
```

```
        <xsd:restriction base="xsd:boolean"></xsd:restriction>
</xsd:simpleType>
```

```
<xsd:simpleType name="ComIbmMrm_BaseValueBinary">
```

```
5        <xsd:restriction base="xsd:hexBinary"></xsd:restriction>
</xsd:simpleType>
```

```
<xsd:simpleType name="ComIbmMrm_BaseValueGYear">
```

```
        <xsd:restriction base="xsd:gYear"></xsd:restriction>
```

```
10 </xsd:simpleType>
```

```
<xsd:simpleType name="ComIbmMrm_BaseValueGYearMonth">
```

```
        <xsd:restriction
```

```
base="xsd:gYearMonth"></xsd:restriction>
```

```
15 </xsd:simpleType>
```

```
<xsd:simpleType name="ComIbmMrm_BaseValueGMonth">
```

```
        <xsd:restriction base="xsd:gMonth"></xsd:restriction>
```

```
</xsd:simpleType>
```

```
20
```

```
<xsd:simpleType name="ComIbmMrm_BaseValueGMonthDay">
```

```
        <xsd:restriction base="xsd:gMonthDay"></xsd:restriction>
```

```
</xsd:simpleType>
```

```
<xsd:simpleType name="ComIbmMrm_BaseValueGDay">
  <xsd:restriction base="xsd:gDay"></xsd:restriction>
</xsd:simpleType>
```

5

```
<xsd:annotation>
  <xsd:documentation>
    ComIbmMrm_Anonymous_xxx type to be used when a
complex type includes a simple type
  </xsd:documentation>
```

10

```
</xsd:annotation>

<xsd:simpleType name="ComIbmMrm_AnonString">
  <xsd:restriction base="xsd:string"></xsd:restriction>
</xsd:simpleType>
```

15

```
<xsd:simpleType name="ComIbmMrm_AnonInt">
  <xsd:restriction base="xsd:int"></xsd:restriction>
</xsd:simpleType>
```

20

```
<xsd:simpleType name="ComIbmMrm_AnonDateTime">
  <xsd:restriction base="xsd:dateTime"></xsd:restriction>
</xsd:simpleType>
```

```
<xsd:simpleType name="ComIbmMrm_AnonFloat">
```



```

        <xsd:restriction base="xsd:float"></xsd:restriction>
    </xsd:simpleType>

```

```

<xsd:simpleType name="ComIbmMrm_AnonDecimal">

```

```

5      <xsd:restriction base="xsd:decimal"></xsd:restriction>
    </xsd:simpleType>

```

```

<xsd:simpleType name="ComIbmMrm_AnonBoolean">

```

```

10      <xsd:restriction base="xsd:boolean"></xsd:restriction>
    </xsd:simpleType>

```

```

<xsd:simpleType name="ComIbmMrm_AnonBinary">

```

```

        <xsd:restriction base="xsd:hexBinary"></xsd:restriction>

```

```

    </xsd:simpleType>

```

```

15 </xsd:schema>

```

Example: The following example shows the equivalent XML Schema representation for a complex type, which extends a simple type String and includes a simple type Integer.

```

<?xml version="1.0" encoding="UTF-8"?>

```

```

20

```

```

<schema xmlns="http://www.w3.org/2001/XMLSchema"

```

```

    targetNamespace="http://www.ibm.com"

```

```

    xmlns:wmqi21Example="http://www.ibm.com">

```

```
<annotation>
  <documentation>
    MRMSequenceExtendingBaseTypeAndIncludingSimpleType
    MRMChoiceExtendingBaseTypeAndIncludingSimpleType
```

5                   They extend from a simple type String and include  
simple type Integer

```
  </documentation>
</annotation>
```

10           <include schemaLocation="wmqi21.xsd" />

```
<complexType
  name="MRMSequenceExtendingBaseTypeAndIncludingSimpleType"
  mixed="true">
```

15           <sequence>
              <sequence minOccurs="0" maxOccurs="0">

```
              <element
name="dummy_elem_string_inheritance"
type="wmqi21Example:ComIbmMrm_BaseValueString" minOccurs="1"
20           maxOccurs="1"></element>
```

```
              </sequence>
              <element name="elem1" type="string"></element>
              <sequence minOccurs="0" maxOccurs="0">
```

```
        <element name="dummy_elem_included_type_int"
type="wmqi21Example:ComIbmMrm_AnonInt" minOccurs="0"
maxOccurs="1"></element>
```

```
    </sequence>
```

```
5        <element name="elem2" type="integer"></element>
```

```
    </sequence>
```

```
</complexType>
```

```
<complexType
```

```
name="MRMChoiceExtendingBaseTypeAndIncludingSimpleType"
```

```
10 mixed="true">
```

```
    <sequence>
```

```
        <sequence minOccurs="0" maxOccurs="0">
```

```
            <element
```

```
name="dummy_elem_string_inheritance"
```

```
15 type="wmqi21Example:ComIbmMrm_BaseValueString" minOccurs="1"
```

```
maxOccurs="1"></element>
```

```
        </sequence>
```

```
        <choice>
```

```
            <element name="elem3"
```

```
20 type="string"></element>
```

```
        <sequence minOccurs="0" maxOccurs="0">
```

```
            <element
```

```
name="dummy_elem_included_type_int"
```

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```
type="wmqi21Example:ComIbmMrm_AnonInt" minOccurs="0"
maxOccurs="1"></element>
```

```
</sequence>
```

```
<element name="elem4"
```

5 type="integer"></element>

```
</choice>
```

```
</sequence>
```

```
</complexType>
```

10 <element name="mrmSequenceElement"

```
type="wmqi21Example:MRMSequenceExtendingBaseTypeAndIncludingSimpleType"></element>
```

```
<element name="mrmChoiceElement"
```

15 type="wmqi21Example:MRMChoiceExtendingBaseTypeAndIncludingSimpleType"></element>

```
</schema>
```

20 Here is the instance document pertaining to mrmSequenceElement whose type is MRMSequenceExtendingBaseTypeAndIncludingSimpleType. Note that the dummy\_elem\_string\_inheritance mirrors the inheritance from simple type String and 0123456 mirrors the inclusion of simple type int.

```
<?xml version="1.0" encoding="UTF-8"?>
```

```
<wmqi21Example:mrmSequenceElement
```

25 xmlns:wmqi21Example="http://www.ibm.com"

```
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
```

```

        xsi:schemaLocation="http://www.ibm.com
wmqi21Example.xsd ">
    dummy_elem_string_inheritance
    <elem1>elem1</elem1>
5      0123456
    <elem2>0</elem2>
</wmqi21Example:mrmSequenceElement>

```

10 The following is the instance document pertaining to mrmChoiceElement whose type is MRMChoiceExtendingBaseTypeAndIncludingSimpleType. Note that the dummy\_elem\_string\_inheritance mirrors the inheritance from simple type String. Due to the choice construct, only elem3 is present in the instance document.

```

15 <?xml version="1.0" encoding="UTF-8"?>
    <wmqi21Example:mrmChoiceElement
        xmlns:wmqi21Example="http://www.ibm.com"
        xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        xsi:schemaLocation="http://www.ibm.com wmqi21Example.xsd ">
        dummy_elem_string_inheritance
20    <elem3>elem3</elem3>
    </wmqi21Example:mrmChoiceElement>

```

25 Note that both of the above instance documents are valid because the **mixed** flag was set to true on their respective complex types.

30 The figure illustrates an example system employing this invention. A customized parser 10, (which may be any known parser capable of handling the W3C XML schema, modified to operate as aforescribed) has available to it the extended W3C XML schema 12. The extended W3C XML schema extends the standard W3C XML schema with the aforesaid customized simple types. In operation, an XML stream 14 inputs the parser 10, causing the parser to generate events 16. The customized parser 10 may be a processor loaded with

software from a computer readable medium 20, such as a diskette, CD-ROM, memory chip, or a file downloaded from a remote source.

5 Rather than wrapping elements of the custom simple types in a group with *minOccurs* and *maxOccurs* set to zero in order to ensure that a “regular” XML parser (i.e., an XML Schema compliant parser which is not configured to operate in accordance with this invention) will ignore these elements, an alternate approach may be used. More specifically, the *minOccurs* and *maxOccurs* of each of these elements is set to zero. Thus, a “regular” parser will ignore these elements. However, an annotation statement (which will also be ignored by a “regular” parser) is employed to give the parser of this invention the information as to the “real” *minOccurs* and *maxOccurs* of each of these elements. The customized parser recognizes this information by virtue of the use of an “appinfo” statement in the annotation.

15 This pattern is used for a complex type that has the content model set to “all” group (which does not allow sequence or choice group elements). In this case the dummy element is embedded inside “all” group.

20 The dummy element pertaining to the inheritance of simple type is best placed as the very first element in the complex type. For the complex type having the content model “choice”, the top level content model is set to sequence, the dummy element pertaining to inheritance of simple type is best placed as the first element, and the actual choice content follows the dummy element, as illustrated in the type

25 MRMChoiceExtendingBaseTypeAndIncludingSimpleType in the following example.

```
<?xml version="1.0" encoding="UTF-8"?>
<schema xmlns="http://www.w3.org/2001/XMLSchema"
  targetNamespace="http://www.ibm.com"
  xmlns:wmqi21Example="http://www.ibm.com">
  <annotation>
```

```
<documentation>
```

```
MRMSequenceExtendingBaseTypeAndIncludingSimpleType
```

```
MRMChoiceExtendingBaseTypeAndIncludingSimpleType
```

```
5         they extend from a simple type String and it
include simple type Integer
```

```
</documentation>
```

```
</annotation>
```

```
10 <include schemaLocation="wmqi21.xsd" />
```

```
<complexType
```

```
name="MRMSequenceExtendingBaseTypeAndIncludingSimpleType"
```

```
mixed="true">
```

```
15     <sequence>
```

```
        <element name="dummy_elem_string_inheritance"
```

```
type="wmqi21Example:ComIbmMrm_BaseValueString"
```

```
minOccurs="0" maxOccurs="0" />
```

```
20     <element name="elem1" type="string" />
```

```
        <element name="dummy_elem_included_type_int"
```

```
type="wmqi21Example:ComIbmMrm_AnonInt" minOccurs="0"
```

```
25 maxOccurs="0">
```

```
        <annotation>
```

```
            <appinfo
```

```
source="WMQI_APPINFO">MinOccurs=0,MaxOccurs=1</appinfo>
```

```
        </annotation>
```

```
30    </element>
```

```

        <element name="elem2"
type="integer"></element>
    </sequence>
</complexType>

```

5

```

<complexType
name="MRMChoiceExtendingBaseTypeAndIncludingSimpleType"
mixed="true">
    <sequence>

```

10

```

        <element
name="dummy_elem_string_inheritance"
type="wmqi21Example:ComIbmMrm_BaseValueString"
minOccurs="0" maxOccurs="0"></element>

```

15

```

    <choice>
        <element name="elem3" type="string" />

```

20

```

        <element
name="dummy_elem_included_type_int"
type="wmqi21Example:ComIbmMrm_AnonInt" minOccurs="0"
maxOccurs="0">

```

25

```

        <annotation>

        <appinfo>MinOccurs=0,MaxOccurs=1</appinfo>
    </annotation>
</element>

```

30

```

        <element name="elem4"
type="integer"></element>
    </choice>

```



```
</sequence>
```

```
</complexType>
```

```
<element name="mrmSequenceElement"
```

```
type="wmqi21Example:MRMSequenceExtendingBaseTypeAndIncludingSimpleType"></element>
```

```
<element name="mrmChoiceElement"
```

```
type="wmqi21Example:MRMChoiceExtendingBaseTypeAndIncludingSimpleType"></element>
```

```
</schema>
```

As an alternative to providing each custom simple type with a name that will be recognized by the custom parser as indicating one of an embedded simple type or an inherited simple type, the name of the dummy element can be used for this purpose. Thus, there would be a set of names for dummy elements, each name representing one custom simple type.

Other modifications will be apparent to those skilled in the art and, therefore, the invention is defined in the claims.